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Bringing the Enterprise System to the Frontline Intertwining Computerized and Conventional Communication at BT Europe

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BRINGING THE ENTERPRISE SYSTEM TO THE FRONTLINE - INTERTWINING COMPUTERISED AND CONVENTIONAL COMMUNICATION AT BT EUROPE

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Abstract

This paper draws on the need to understand how mobile technology is implemented and used at the organisational level. IT is a general-purpose technology and therefore its use involves a high degree of uncertainty and ambiguity. Moreover, IT vendors and system developers tend to be very unambiguous in their rhetoric about mobile technology opportunities. Therefore, managers have trouble to identify the real scope, the functionality and the impact of new mobile applications. However, these three types of uncertainties need to be handled in change management projects where new information technology is involved. Gradual uncertainty reduction at these three different levels, i.e. what technology can do; will technology work; and will users adopt it, is studied in this paper. This is achieved through an analysis of the implementation process of an information system where mobile terminals are used to give service technicians access to the ERP system at BT Europe, a leading supplier of forklift trucks. The analysis shows how the three levels of uncertainty interact, and how the computerised parts of the information system are complemented by mindful intertwining with the non-computerised communication and manual data processing, in order for the information system to work.

Keywords: Mobile application, IT implementation, Uncertainty, Intertwining.

1 INTRODUCTION

The possibilities of mobile technology continue to broaden and expand. Many organisations have invested or consider investing in this technology. The present slowdown in investments is expected to be temporary, and hopes for the future are high. One area that is attracting attention is the use of mobile terminals that can give mobile employees access to central information systems, such as ERP systems.

At the level of the business enterprise, investment decisions related to new technology in general and mobile technology in particular are usually fairly challenging. Some industry analysts and telecommunications providers claim dramatic business improvements, but many IT and business managers have expressed concern that the business value of mobile technology may not be quite as substantial as suppliers would like them to believe. One reason for this may be IT's "ambiguous" (Earl 2003) and open-ended character (cf. Orlikowski & Hofman, 1997; Asaro 2000). Earl (2003) proposes that three important sources of ambiguity are uncertainty regarding what technology can do, whether the technology will work, or if it will even be adopted. The aim of this paper is to describe and analyse the uncertainty resolution process in a large-scale implementation of mobile technology, and the interplay of new and old technology and organisational solutions. This paper analyses the implementation process of an information system (EASY- Engineer Administration SYstem) at a leading supplier of forklift trucks where mobile terminals are used to give service technicians access to the ERP system. The mobile terminals provide its service technicians with an interface to structured, written data in order to rationalise the entire service order process. The project was carried out as a follow-up to a business process reengineering (BPR) project that resulted in the implementation of a common enterprise resource planning (ERP) system across the European division of the company.

The article is organised as follows. First, we present models central to the article, followed by a brief account of the research method. Then the implementation of the mobile application is described. The description includes the project background, a number of identified benefits, the project itself, the organisational impact and the management of change within the project, and finally some technical considerations. We conclude the paper with a discussion of three different kinds of ambiguity of IT implementations that are based on open-ended technologies, how the uncertainties interact and how computerised and manual parts of the information system intertwine to create a functioning system.

2 UTILISING AMBIGUOUS TECHNOLOGY

In research literature, it has long been acknowledged that technology interacts with other aspects of organised work, and that change in one aspect affects the others. Leavitt's "diamond" (1965) suggests that interaction with and among people, organisation, and task are important when dealing with technological change. Lundeberg's "levels of abstraction" (1993), dealing specifically with IS-related change, further divides technology into hardware and software, and distinguishes between information and activities. Talking of "results", rather than "tasks", perhaps reflects the rhetoric of the 1990's, while "people" and "behaviour" are seen as two important aspects pertaining to the individuals who are involved or affected. Both these models, and others like them, specify important subsystems that need to function in ongoing operation, and that require careful planning and consideration.

Orlikowski et al. (1997), develop the idea that IT-related change, especially regarding partially novel and "open-ended" technology, cannot be fully planned. Important opportunities – and obstacles – will arise, and be noted, over time, as people learn about the technology being applied, and reflect on the interaction between the computerised and non-computerised aspects of the work being performed. An opportunity-based strategy for change acknowledges, and tries to benefit from, the emergent and changing understanding of IT-related change over time.

Earl (2003) further develops the notion of uncertainties connected with the use of ambiguous technology, suggesting that the actual benefits derived from the use of IT in an organisation will always be uncertain when envisaged in advance. He proposes three important types of uncertainties: enabling uncertainty, what technology can do; commissioning uncertainty, whether the envisaged application can be built; impact uncertainty, whether the application will be adopted and gainfully used. Robey, Schwaig & Jin (2003), finally, turn the focus back to the interaction between the virtual and the material. They suggest that full digitalisation is probably neither desirable nor feasible. The objective should instead be to develop a mindful intertwining of virtual and material communication. We will draw on these ideas of interrelations and interactions between aspects of technology and the use of it, of different types of uncertainties, and on the intertwining of computerised and non-computerised aspects when analysing how a vision of computer-supported work is turned into practice.

3 METHOD

The BPR project and the hardware and ERP projects that formed the background for the EASY project were studied through interviews and project document studies. Close to 70 interviews with people in these projects, at headquarters and in three of the market companies were performed, and extensive project documentation was made available to that research team, which included one of the present authors and three additional researchers: Linda Askenäs, Klas Gäre and Cecilia Gillgren. The other present author has met with the supplier of the EASY application software. The present authors have in addition interviewed representatives of the EASY project team: one from the service process side at headquarters, one from the division's IT department and a service market manager from a market company. The authors have also been able to study the application itself, and have been given access to training material and project evaluations from a market company. The interviews have been semi-structured (Patton 1990) and lasted between two and three hours each. They have been tape recorded and transcribed in their entirety. The material has been analysed in a qualitative tradition. The interviews and documents relating to Easy have been searched for indications of uncertainties and trade-offs in the development and implementation process. These indications have then been used to explore connections between levels of uncertainty and concerning the intertwining of computerised and non-computerised aspects of the administration process, when viewed as an information system.

4 IMPLEMENTING EASY – COMPUTERISING SERVICE TECHNICIANS ACROSS EUROPE

4.1 Project Background

The organisation in focus for this study is BT Industries, part of the Toyota group. BT Industries is a leading supplier of forklift trucks, with a world market share of more than 20%, annual sales of €1.2bn, and 8,000 employees. The company offers a wide range of forklift trucks plus servicing facilities and has manufacturing locations in Sweden, Italy, Belgium, USA and Canada. From the middle of the 1990s onwards, the European division, BT Europe, embarked on an ambitious computerisation venture. A BPR planning project to explore IT enabled business change was carried out. A shared hardware and communication platform was designed and implemented, and after thorough evaluation, an ERP system (Movex) was chosen and rolled out across Europe in a strategic partnership with an ERP supplier.

Having installed a shared information platform, new ideas related to technology-enabled projects started to appear in the organisation. In 2001, BT Europe decided to further improve quality in its customer offering through rationalisation of its service order process. Moreover, the common ERP platform could enable a pan-European project making the exchange of ideas between different local market units possible.

A project group with approximately a dozen participants was formed. The members had different background, coming from local operations, central staff personnel, and technology consultants.

4.2 Identified Possible Benefits

The group identified a number of possible administration-related cost reductions. BT Europe's field service engineers were processing 5,000 assignments daily. Annually, 1.2 million hand-written work orders were delivered on paper to the administrative offices, and fed into BT Europe's back-office ERP system. This was a costly and time-consuming process. BT Europe's service process management decided to implement an automated solution, which extended the back-office system to the field service force by providing them with handheld mobile devices for access to the job, contract, or product information required.

The original idea was to use information technology and to modify the business processes in order to benefit BT's customers and the company itself. Faster service routines could lead to more efficient service operations. Customers would benefit from less risk of human error, faster and more accurate communication and repairs, and more motivated and informed technicians. The technicians could reduce time-consuming processes such as work-order and service-contract processing, and they could access data about products and customers resulting in more informed employees. This could eventually change the role of the technicians to becoming more business oriented. Moreover, increased flexibility to plan their work could lead to more motivated staff. The mobile access to the ERP application would provide technicians with the possibility to plan their work based on the pending work orders, report service orders and assignments, order spare parts, review service contracts, and access extensive data about products and customers. Online reporting would also speed up the invoicing process, thus reducing the amount of capital bound up in the service process.

Service technicians would not only change role but also work practices. The physical work-reports manually delivered on paper to the administrative office would be substituted with virtual work-reports directly fed into the ERP system resulting in automatically completed invoices. A shift from physical work practices to virtual ones would be required when interacting with the mobile terminals. Automated service order process solutions could moreover reduce the administration workload by elimination of manual routines for invoicing, processing work reports and service assignment scheduling. Instead of dedicating time to copy invoices into the system, administrative personnel could focus on giving feedback to service technicians when necessary. A consequence of these new work practices would be to rationalise the back-office function, enabling a reduction of the number of employees.

IT projects can provide organisations with an opportunity to revise work practices and business processes (Davenport 1997), although the opportunity is not always utilised (Asaro 2000). As indicated above, revising work processes in BT Europe was an important aspect of the EASY project. The pan-European character of the project could moreover facilitate benchmarking between local markets and improvement of the service order processes to reflect company best practice. There were thus a large number of potential benefits to be derived from the project. However, the process of getting there was not streamlined. A number of issues had to be dealt with during the project.

4.3 The EASY Project

Although the idea to give service technicians access to the ERP system had appeared already during the BPR study in the middle of the 1990's, the time had not then been considered ripe. Partly, the reason was that reliable and cost-efficient mobile platforms were not yet available on the market. One of BT's main competitors had equipped their service technicians with laptops and printers accessible at the service vans. However, that project was believed to be expensive and not show the benefits the company had hoped for. Managers in BT were pleased that they could learn from the "bleeding edge" experience of others. Part of the lessons learned from that project was that service technician computerisation should be based on easy to use, robust, handheld devices.

Another reason why the project had not been started earlier was the lack of a common hardware and software platform in the company. Then, by the year 2000, mobile terminal development, and the development of administrative software for such terminals, had progressed to the point where computerisation of the service technicians' administrative tasks seemed feasible. Local tinkering had begun (cf. Ciborra 1994), but centrally placed imaginators (cf. Hedberg, Hanson, Dahlgren & Olve 1994) envisaged a more thoroughly transformed organisation than they believed the local imaginators did. Although the centrally placed imaginators did not envisage a business-logic transformation that would revolutionise the industry (cf. Hopper 1990, Cross, Earl & Sampler 1997), they believed substantial benefits would be achieved through co-ordinated action, and state-of-the-art use of mobile technology. To achieve potential benefits of streamlining the service process across the entire division, and to be able to split the development cost, a joint project was initiated by divisional headquarters. Not only had mobile technology developed far enough, but the division also had a sufficiently common administrative platform in place to make a joint service administration possible. Unlike in other cases where ERP implementation has been found to *prevent* business changes (e.g. Hanseth & Braa 1998), in BT Europe the shared Movex platform was *a prerequisite* for further change.

The idea to make BT Europe's 1,150 mobile service technicians more effective was therefore discussed at an annual brainstorming meeting of market and service development held centrally in 2000. Mobile technology was by that time often debated in media and mobile technology opportunities created visions about cost reductions and improved efficiency. Many people at BT regarded the project as a prestigious one. EASY could profile the organisation as a company at the cutting edge of new technology.

From the beginning, BT managers hoped to be able to learn from other companies where similar PDA-based systems for the service function had been implemented. However, such implementations on a multi-country scale could not be found, and the company was obliged to become a first-mover to some extent. BT Europe managers did not want to undertake such a large-scale and innovative project purely on faith, and therefore asked for business case calculations from the market companies. As they had hoped, it turned out that there was a sound business case for a joint project, but that no market company could muster one for developing such a solution on their own. Based on the business case, the EASY project received a go ahead, but the consequences and the details were not yet fully known. Among other things, a degree of uncertainty regarding what technology could do was certainly present. Moreover, functionality to be implemented also evolved as the project matured. As an example, it was not until after the system launch that service managers realised the potential to automatically attach marketing flyers to work order notifications emailed to customers directly after performed repairs. This unforeseen, new communication channel gave EASY also marketing potential.

4.4 Organisational Impact

The intended change was substantial, and for the back-office function it was truly of a reengineering scope (cf. Hammer 1990, Hammer & Champy 1993, Davenport & Short 1990, Cross et al. 1997). Therefore, the development team had a strong participation from back-office functions to access relevant operational knowledge and to achieve organisational credibility (cf. Westelius 1996, Asaro 2000). Those responsible for the project certainly did not want to provoke sentiments of headquarters manipulating the local companies (cf. Markus & Pfeffer 1983), and therefore saw to it that the designing members of the team came from local operations, and that consultants and central staff personnel were only in the team as support to the ones with hands-on knowledge of the business process. In this way, the developers were to a large extent developing their own future, rather than being a specialist team stuck in the middle between demanding management and an oppositional workforce (cf. Howcroft & Wilson 2003).

A lesson from the ERP project was that without a strong enough focus on designing common business processes, a truly shared computer application would be difficult to achieve (cf. Gäre 2003). The project team thus spent close to a year on mapping the present processes in three countries, devising a

redesigned process, and then requiring the service managers in the other countries to perform a gap analysis between the redesigned process and their existing ones. They were required to state what needed to be changed in the current process to implement the new one, and if there were aspects of the existing process that were essential to keep, and would require modification of the new process. In the end, just a couple of close to 70 *use cases* in the new application supported alternative sub-processes. All the others presupposed one common way of carrying out the administrative process.

It was obvious that the EASY project would require a change in the role(s) of service technicians. To some extent, their present worldview and that of back-office personnel were different (cf. Checkland & Scholes 1990). The typical service technician was viewed as having a strong customer focus – the goal was to keep the customer happy by keeping the customer's forklifts operating as reliably as possible and by getting them back into operation as quickly as possible in case of breakdown. However, technicians typically had little idea of the economic aspects of a customer's service contract. Nor were they expected to sell trucks, service contracts or consider when it was time from a BT perspective to replace rental trucks. The role the service technician was moving into, with the introduction of EASY, would be more businessman-like. However, rather than replace the customer-oriented perspective, the ideal would be to let it coexist with a businessman perspective and an administrator's perspective. The new service technician role would be a multiple-identity one (cf. Pratt & Foreman 2000, Foreman & Whetten 2002). In addition, administrative accuracy and correct filling-out of forms would now be expected from each service technician. They would in future take the full responsibility for quickly and reliably feeding the ERP system with data on service work (cf. Petri 2001), without back-office serving as support and filter, cleaning data and translating between the service technician's world and the computer system's. Concerning information provision to the service technician, the objective in EASY was certainly not to create ambiguity to make them think creatively (cf. Hedberg & Jönsson 1978), but rather to supply them with as well-tailored data as possible, to reduce the interpretive space needed to process the data (cf. Thompson 2003). The service technician's focus should initially still be on servicing trucks efficiently, not on making creative interpretations of the data they entered and retrieved. However, over time, the development of a businessman-like role would require more interpretation of data, such as figuring out when it is time to sell the customer a new truck, or realise that the repair history of this rental truck suggests that we (BT) replace it to lower our total cost, etc.

4.5 Change Management

Change initiatives expecting a change in perceptions of identities or regarding tasks or even the existence of work, can be expected to evoke strong reactions (Checkland et al. 1990, Huy 1999, Fiol & O'Connor 2002). The need to feel support in taking the step into the unknown is then highly important (Schein 1993, Huy 1999). In BT Europe, they have tried to achieve this through ambitious training programs aimed at back-office personnel and service technicians, and have provided a filtering function that buffers for errors the service technicians make in handling the administrative software, until the service technician masters the application at a virtually error-free level. Regarding the back-office personnel, the strategy has been to cut the number of staff at the beginning of the implementation, partly in order to get the remaining staff highly motivated to give feedback to the service technicians so they handle the application with fewer and fewer errors. A decreasing amount of errors from service technicians will reduce the workload for back-office personnel. The drawback of this strategy is that the workload on the (reduced) back-office staff is high and it is difficult for them to give adequate support to the service technicians. The learning period for the technicians is thus considerably longer than it would have been, given ample feedback. On the other hand, having kept people in back-office that would ultimately be laid off, would give them an incentive to prove that they are needed, and thus maybe keep their job, by showing that the service technicians can not handle the application well enough on their own. The equation is thus not an easy one, and it is not obvious that it will ever be possible to determine if the path chosen was better or worse than an alternative one.

Further development of the application and its use would be based on a mix of planned changes and opportunity-based change (cf. Mintzberg 1989, Orlikowski et al. 1997). Some further development could already be foreseen, based on ideas that had been deferred from earlier stages for budget reasons or in order not to risk complicating the application design that had been planned for that developing stage. In an organisation, change is taking place continuously, at a micro level, because people are not machines, and do not faithfully repeat a process in an unchanging manner forever (cf. Tsoukas & Chia 2002). The challenge in the EASY project (and for future operation) was on the one hand to stop change, getting people to adhere faithfully to the carefully designed service administration process, while not stifling initiative (cf. Galgano 2002) and instead channelling it into a ”versioning” system. The process should be carried out in the agreed manner. Change ideas should be submitted to the process owner, evaluated, prioritised, and, if accepted by the process owner, sorted into the next or a future version of the service process. Preserving change initiative while not being in charge of deciding on implementing the changes is challenging, and can lead to re-enactment rather than change becoming the ideal people follow (Westelius & Askenäs 2001), or require strong and visible feedback on the handling of the proposed changes (Borovits & Neumann 1988, Petri 2001).

4.6 Technological considerations

At the beginning of the project, few decisions regarding the technological platform were made. However, two agreements were made relatively early. One was that the operating system had to be future-proofed and relatively well established so that competition could be guaranteed. To provide 1,150 technicians with portable devices could otherwise become expensive. At the decision point, Palm OS enjoyed a larger installed base. However, terminal suppliers consulted by BT managers foresaw Pocket PC to become more available in the future. This led to the choice of Pocket PC-based solutions, because that platform seemed to offer a lower risk of terminal supplier lock-in than other competing solutions. The other was to build the application based on offline synchronisation update methods and GSM networks. Tests had shown that connectivity was often a problem and that GSM was the only type of mobile network that offered a relatively extensive coverage in the dozen European countries where the application would be implemented. Technicians often work in areas with bad network connectivity, such as in rural areas, and inside industrial buildings with massive cement walls.

Using GSM networks, users at BT Europe can synchronise data, work offline and then synchronise data again afterwards. The solution provides access to all necessary information through the PDA, so service technicians can carry out assignments independently of external factors, such as the lack of a network connection. However, service technicians are expected to synchronise several times a day to update data both in the handheld devices and in the ERP system. To facilitate this, a one-button synchronization feature was built. Because of the selected networking solution, connection between PDA and the ERP system via middleware has to be initiated from the PDA. However, the mobile telephones the technicians carry provide back-office with a way to reach a specific technician. Back-office can send an SMS to a technician’s cell phone to indicate when a new urgent work order needs to be downloaded and taken care of. If the technician has not synchronised the PDA within a certain period of time, a follow-up mail is sent to back-office, where further action to allocate the service task can then be undertaken.

When the system had been implemented, service technicians began to experience the terminals as slow. The application is uploaded from resident to primary memory and runs in primary memory. It can take several seconds to change screen image. At the beginning, this was not an issue. However, as technicians became more acquainted with the tool, waiting for the next screen to load was experienced as highly annoying, and gave the impression that filling out electronic forms was more cumbersome and took more time than filling out the paper-based version. However, recent measurements have shown that the computerised process seems to be no worse, and perhaps even faster overall than the

paper-based process, but the stress of not being able to control the progress yourself leads to a subjective evaluation that differs from the measurements.

In general, during the pilot installations, the PDAs have proven reliable, the offline work mode and synchronisation processes have worked, and the training of the service technicians and back-office personnel has gradually led to the establishment of a new work process that is close to the intended one. Believing in the validity of the business case, the service process management of BT Europe then decided on a complete rollout of the application to all mobile service technicians in all the market companies. The rollout progressed according to plan, and now, March 2004, the 1,150 mobile service technicians use EASY. At the same time, work on enhanced versions of the application and the administration process is going on. Over time, the initial uncertainty will resolve, while new opportunities – and problems – will appear and be addressed.

5 DISCUSSION

The story of EASY could be viewed as an account of deployment of mobile technology. However, as the case illustrates, that would be a too limited scope. It is rather a story of change management, where mobile technology is an important aspect, but one that has to intertwine with work processes and other technologies.

Moreover, a challenge that managers face when deciding on new technology investments is that change management involving open-ended technologies is an uncertain and ambiguous process. This is so because change related with open-ended technology is an ongoing process rather than an event with an endpoint after which the organisation can expect to return to a reasonably steady state (Orlikowski et al. 1997). In the EASY case, this shows up as a number of projects that follow on each other, and as a learning process regarding the use of the EASY application. This learning process is far from finished today, and will also surely come to incorporate new steps from as yet unforeseen follow-on projects. Some uncertainty can be resolved through planning at an early stage, but some remains and will only resolve gradually as time passes.

In addition, new challenges will arise as the use of the open-ended technology develops. Orlikowski et al. (1997) distinguish between emergent and opportunity-based change. Emergent changes are changes that were not intended, but developed "spontaneously from local innovation". Opportunity-based changes are not anticipated either, but are purposefully implemented in the change process in response to an unexpected opportunity, breakdown or event. A pan-European project, such as EASY, spanning different cultures, different organisational units, and a large number of users with little or no contact with most other users, is subjected to many forces pulling in different directions. It is then important to meet the unexpected with opportunity-based change rather than by relying on spontaneous, emergent processes. Otherwise the envisaged, shared service administration process will not be long-lived, but soon dissolve into local variants, and then the shared mobile application will probably become a hindrance to development to local companies who cannot afford developing the application on their own.

To address this aspect, EASY has been set up with a process for handling new ideas, demands and opportunities. Suggestions for changes and further development of the process or the computer application should be substantiated with a business case, and evaluated centrally in BT Europe. To allow for orderly development of the application and uniform implementation, a versioning strategy is followed, where suggested changes that would disrupt the present version are likely to be deferred to a later version. The submission of suggestions is not expected to develop unaided; an IS co-ordinator has been appointed and given the task of encouraging exchange of good ideas for use of the application. Earlier experience from impromptu modifications of software have made both central and local managers wary of unexpected complications, and the service process is believed to be mature enough to allow for a somewhat slower process for implementing good ideas.

As Earl (2003) has suggested, the ambiguities of an IT-related venture can be analysed in terms of three essential uncertainties: enabling, commissioning and impact uncertainties. Resolving the *enabling uncertainty*, determining what could, and could not, be achieved with the help of mobile technology, is a first step. The original vision behind the EASY project was to provide the service technicians with a direct, computerised link to the shared ERP platform, rather than having them rely on paper- and telephony-based communication with back-office personnel. The early vision of online access proved infeasible. GPRS coverage was not sufficient on a geographical basis, and local connectivity problems would add to make off-line solutions necessary. Thus, that part of uncertainty concerning what technology could do was resolved. The uncertainty concerning convenient portable terminals resolved itself in a more positive manner. Expensive and cumbersome PC terminals developed into more robust, less expensive and more reliable PDAs. However, PDAs are developed for office workers, consultants, etc, and are equipped with a number of applications that service technicians are unfamiliar with and that could cause confusion and prolong the training period needed. Part of making the PDAs suitable as terminals for EASY was then to block out standard functionality that was not required in the EASY application. Thus, the idea of portable terminals that all 1,150 technicians could use finally seemed to be feasible. The business case they had developed indicated that the technical capabilities expected from EASY had sufficient economic potential. This was then supplemented, for example, by the rather late realisation that the application delivering electronic work order notifications to customers could also be used to deliver campaign leaflets and offers. Further examples of resolving of the enabling uncertainty are certain to evolve over time. The challenge in the BT case will be to allow experimenting within the fairly strict, newly designed administrative process, and to identify and grow the good ideas into widely implemented practice.

The next level, *commissioning uncertainty*, was an issue right from the start. IT projects can easily escalate or fail to deliver altogether, and people within BT Europe wanted to avoid this as far as possible. One attempt was appointing an experienced project manager. Starting with developing and agreeing on the new administrative process before finally choosing the actual handheld device and programming the application, and then keeping a strict regime concerning versions and changes to the specification was another. Yet another attempt was choosing a widely licensed technology from a powerful company like Microsoft, rather than proprietary technology from a smaller, specialised player. A final example was letting suppliers “go public” with the case, and thus making their public image dependent on the success of the development. So far, the strategy seems to have worked. The project has kept to the schedule, and it has also been possible to take advantage of an improved version of PDA that appeared on the market after the first pilot tests of the application.

There have also been parts of the commissioning uncertainty that have been solved through different kinds of intertwining (Robey et al. 2003) between the new and existing modes of communication. One is that error-free input by service technicians can not be achieved through programmed controls alone. To deal with this, a filtering function was built in the middleware, giving backoffice an opportunity to set filtering conditions on an individual level for manually scanning transactions before releasing them to the ERP system proper. Another example is that due to the way the synchronisation is initiated from the PDA, not from the ERP system or from back-office, efficient handling of rush orders includes the use of mobile telephones. The service technicians were already equipped with telephones, used them often, and will continue to use them. Calling the telephone or sending an SMS to it is thus a way to reach a specific technician. But informing of the details of a new job by telephone, rather than via the PDA would be an awkward duplication of the administrative process. Thus, the telephone is used to signal that it is time to synchronise the PDA. Similarly, since the EASY application is not built to give online access to stock levels of spare parts, that feature is solved by telephone when deemed important by the service technician. The order for the spare part is placed via the PDA, but when it is important to know if an unusual spare part is actually in stock, the service technician calls someone with direct access to the ERP system.

Enabling uncertainty and commissioning uncertainty can be viewed as mere hurdles. You have to get over them, but they do not guarantee success. Unless *impact uncertainty* is resolved in a satisfactory

manner, the business case projections will not be met. In the EASY project, a start was to have front-line managers and users develop the specification with support from central managers, IT specialists and consultants, rather than the other way round. The gap analysis in the companies that did not take part in the development project was another element in reducing the impact uncertainty. Here, a problem is that the enabling uncertainty is larger for someone who has not been part of the development project, and who has a less intimate understanding of what the actual technical flexibility will be, than the understanding possessed by those who have spent months or even years exploring the issue. There is thus a risk of not truly realising what gaps there will be between the actual, computer-supported process and the present, manual one. Since the implementation is well under way, there do not seem to have been any major surprises, but the late addition of at least one important *use case* alternative indicates the presence of some impact uncertainty after it was believed that it had already been dealt with.

Strong focus on user training has been another way to reduce impact uncertainty, and so far it appears that is has been successful. Reportedly, customers have also been positive to the introduction of EASY, and want to see it developed even further. Perhaps the most challenging part regarding impact so far has been to get the feedback loop from back-office personnel to technicians to work. With the manual process, clerks at back-office could correct much of the inaccuracies that existed in the service job reports that arrived on paper. For the new process to work as intended, technicians need to achieve error-free reporting. The filtering function described above gives backoffice the possibility to filter out transactions for control based on the data-entry proficiency of the individual service technician. But to learn from their mistakes the technicians need feedback concerning inaccuracies. Some of it can be handled by controls in the application itself, but some is less obvious. Should this job be charged to the customer or is it covered by a guarantee, or by a service contract? Is this replacement of this wheel noted on the right truck or on another of the same model? Is this spare part in my van really registered in the ERP system? These and a host of other questions need to be handled, and typically require communication between the technician and another human being, and maybe even repeatedly, before they become part of the active knowledge of the service technician. This again is an example of the need for intertwining between the new, mobile application and previously existing modes of communication. Given efficient feedback, this learning process will require many months. Given less efficient feedback, it will take longer or perhaps even result in a negative answer to the question: “Will EASY meet the high expectations?”

6 CONCLUSIONS

If we look at the conclusions the actors in the project reached and the decisions and actions they took at the different levels of uncertainty, interrelated chains become evident. At the enabling level, the wish for a light, robust terminal that would be likely to be useful in the service technician job and at a sufficiently low price finally found a match when PDAs where believed to meet the requirements. Nevertheless, actually having service technicians interact with the ERP system would require correct input of data from the service technicians. In addition, adoption would be unlikely unless the service technicians felt that they could master the application. The design of the PDA with a pen-like pointing device and touchscreen instead of keyboard seemed to match service technicians’ present skills, but would require the construction of a menu-based interface. Such an interface has since been built, but by itself it does not guarantee complete and error-free input, and has also started to appear annoyingly slow to the more experienced users. *Thus, what at one point seems to lessen impact uncertainty can at another point in time increase it.*

To facilitate the role transition for the service technicians, the error-reducing capabilities of the software was complemented with a filtering function, prompting back-office personnel to manually check input from service technicians before passing the transactions on to the ERP system. If back-office would also give feedback to service technicians and to trainers (outside the EASY application), the service technicians could with time improve their handling of the application. *Thus, attempts to*

improve the EASY application at the commissioning and impact levels had to be complemented by manual routines and conventional communication.

Similarly, the synchronisation of the PDA and the ERP system relied on service technician initiative. At the commissioning level, it was possible to build an easy to use, one-button synchronisation function, but at the impact level, it rested on the routine that service technicians actually synchronise a number of times a day. In addition, to solve push of urgent service jobs from back-office to service technicians, the PDA application had to be supplemented with SMSs to the service technicians' cell phones, prompting them to synchronise the PDA. Also, the replication of spare part availability data from the ERP system to the middleware being less than real-time, important spare part availability had to be checked via telephone, outside the EASY system. *Thus, consequences of design choices affected the impact level, and required intertwining of the EASY application with non-computerised communication support to achieve certain functionality.* The analysis of chains linking different levels of uncertainty, intertwining computerised and non-computerised communication between actors, modifying roles and intertwining manual routines and IT processing of data could be carried to a greater depth, but the examples above illustrate our basic idea.

In technology-related change process literature, it has long been noted that successful change demands attention to the interplay between technology, tasks and organisation, and with attention to the people who are involved in the change (e.g. Leavitt 1965, Checkland et al. 1990, Lundeberg 1993). Often such literature has had a strong focus on planning, thereby trying to overcome obstacles and reduce uncertainty, while other authors have focused the emergent nature of change (e.g. Mintzberg 1989, Orlikovski et al. 1997, Tsoukas et al. 2002). In our analysis, we have attempted to combine these ideas, illustrating how the uncertainties of providing mobile service technicians access to a central ERP system have been resolved over time, while new problems and opportunities have arisen. The analysis has focused on three levels: uncertainty concerning what technology can do (enabling uncertainty), concerning if the envisaged application can be built (commissioning uncertainty), and concerning if the application will be gainfully used (impact uncertainty). We have also shown how these levels interact, and how the computerised parts of the information system are complemented by *mindful intertwining* of the computerised application and non-computerised communication and manual data processing, in order for the information system to work as intended.

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